EECS 270 Fall 2021

Homework 1

Due Friday, September 10 @ **5:00 PM** on Gradescope

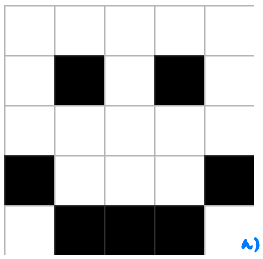
This is an individual assignment, all of the work should be your own.
Write neatly or type and show all your work for full credit.
Have your name and unique name on the front page of your submission.

Total Points: 70

1. **[10 points]** *ASCII text:* A suspicious individual gives you a binary dump of a file and you decide you want to read it. The numbers on the left of the pipes indicate which position the left-most 8-bit datum on the row is, 0-indexed (e.g. on the top row, 01001000 is at position 0 and 00101100 is at position 3). Convert the 8-bit data into ASCII text (you should get actual words; write "NUL" when you encounter a 00000000):

0	01000011	01101111	01101110	01101110
4	01101111	01110010	00100000	01101001
8	01110011	00100000	01110100	01101000
12	01100101	00100000	01100010	01100101
16	01110011	01110100	00100000	01000111
20	01010011	01001001	00100000	01101001
24	01101110	00100000	01000101	01000101
28	01000011	01010011	00100001	00000000

2. **[20 points]** *Image Encoding:* Images are encoded in binary and then often compressed to save space. Use the following 5x5 pixel image (25 individual values) of black (represented as 1) and white values (represented as 0) for the following questions.



   a. (5 pts) Write the bits of the image from left to right, then top down (like writing English). For readability you can group them in sets of 4 of 8 (for example *0111 0101 1010....*)

   b. (10 pts) You realize you may be able to compress the image by grouping strings of the same color together. Use a scheme where you encode strings of pixels into 4 bit nibbles, the leftmost bit of each chunk being the color followed by a 3 bit binary number of the number of pixels (i.e. if you have 3 black pixels in a row followed by 2 white pixels you would have 1011 0010).

   c. (5pts) Was the above compression scheme a good scheme for this particular image? Why or why not?

   d. (Optional: bonus points) Describe a compression scheme that works better than the previous scheme or writing the individual pixel bits and then use it to compress the image.

3. **[10 points]** *Moore's Law:* You are a senior chip designer at major chip manufacturer Dintel. You have made a state-of-the-art chip containing 3 billion transistors. The marketing team asks you a few questions for a chip 12 years in the future. You decide to answer by using Moore's Law (the number of transistors on integrated chips doubles approximately every 18 months) using your new chip as a point-of-reference:

a. (5 pts) How many times smaller would a chip containing the same number of transistors be?

b. (5 pts) How many transistors would a chip of the original size be able to contain?

4. **[20 points]** *Boolean Equations:* You are an employee at Bamazon, a company that ships many products to its customers. Packages can be small, heavy, and/or expensive. Your location has 4 trucks, each specialized to carry different combinations of packages. Write Boolean equations to represent the packages each truck is specialized to carry using the encodings: *s* for small, *h* for heavy, and *e* for expensive

   a. (5pts) Truck 1 is specialized to carry all packages that are both small and light (i.e. not heavy), but also packages that are expensive, small, and heavy. $sh' + esh$

   b. (5pts) Truck 2 is specialized to carry packages that are large (i.e. not small) and inexpensive (i.e. not expensive), but also packages that are heavy and expensive. $s'e' + he$

   c. (5pts) Truck 3 is specialized to carry packages that are large, light , and inexpensive, but also packages that are both small and expensive. $s'h'e' + se$

   d. (5pts) Oh no! Truck 4 broke down and you need to buy a new truck. Write a Boolean equation that describes what packages your other three trucks *cannot* carry so you can buy a truck to carry the other packages. $sh'(e'+e) + esh + s'e'(h'+h) + he(s'+s) + s'h'e' + se(h'+h)$

5. **[10 points]** *Circuit Drawing:* please draw a circuit diagram using an appropriate combination of logical gates (i.e. AND, OR, NOT XOR, NAND, NOR, or XNOR) for the following boolean equations.

   a. (5 pts) $s = c_{in} \oplus (a \oplus b)$

   b. (5 pts) $c_{out} = ab + bc_{in} + ac_{in}$

   c. (Optional: bonus points) If you wanted to implement both equations, could you manipulate the boolean equations to use less logical gates than a straightforward implementation of the above equations? Explain. (hint: think if there are partial results that could be shared by both equations.)

$= sh'e' + sh'e + she + s'h'e' + s'he' + s'he + she + s'h'e'$
$100 \quad 101 \quad 111 \quad 000 \quad 010 \quad 011 \quad 111 \quad 000$
$+ sh'e$
101
$+ she$
$000.$

$s \; h \; e$ $\quad 100, 101, 111, 000, 010, 011$
$m_4 \quad m_5 \quad m_7 \quad m_0 \quad m_2 \quad m_3.$
$m_1 + m_6.$
$001 \quad 110$

$s'h'e + she'$